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COVER: The Naval Submarine Medical Research Laboratory in Groton, CT, is one of the Navy's most productive research facilities and the subject of this month's cover story on page 10. Cover design by the Editor. Cover photography by HM2 Kevin Kaya.

Pilot Inpatient Obesity Treatment Program

LCDR William L. Griffith, MC, USNR HM1 Edward Owen, USN LT Edward J. Marcinik, MSC, USN

Current estimates indicate that 30-50 percent of the adult population in the United States is obese (20 percent above ideal weight). (*1*) Although the Department of Health, Education and Welfare labeled obesity as the number one dietary problem 25 years ago, (*13*) no well-designed scientific survey has been conducted to assess the prevalence of obesity in Navy personnel.

Well aware of the numerous health hazards associated with obesity, the Navy has begun to express a considerable interest in the weight status of its personnel. (*2,3,4,11*)

An example of this interest was a Navy-sponsored weight reduction program conducted at NRMC Long Beach, CA.

During this program obese individuals attended a number of group meetings designed to develop attitudes of self-responsibility for their eating behavior. They received no special diets other than the broad guidelines of the Overeater's Anonymous (OA) "Blue Sheet" Food Plan. They selected their own food from a standard cafeteria with no special food preparation by the cafeteria staff. Exercise was limited to daily walks of one mile initially with gradual implementation of jogging (1-2 miles) by completion. They also attended nightly Overeater's Anonymous meetings to develop stronger peer identification. The thrust of the entire program was development of personal responsibility for eating behavior. In this manner obese individuals develop a greater awareness of factors related to their obese state and generate methods to deal with these factors more effectively.

Methods and Materials

Subjects admitted to the obesity treatment program were 118 experienced Navy and Marine Corps personnel ($\bar{X}$ = 12.3 years active service) who had performed their jobs satisfactorily and were considered valuable to the Navy despite their obesity problem. These members were selected for treatment in most cases after they had failed traditional weight loss approaches, including exercise (fat platoon), exchange diets, low carbohydrate diets, Weight Watchers, and direct coercion.

The sample was represented by 94 men and 24 women. Ninety of these individuals were enlisted and 28 were officers. Other relevant physical characteristics of the patients can be found in Table 1.

At the inception of the obesity treatment program, participants were asked to fill out a number of demographic, health, and personal history questionnaires. Blood

TABLE 1. Characteristics of Obese Patients

Variable	Mean	S.D. ±
Active Service (Years)	12.3	5.4
Age (Years)	33.2	6.3
Height (cm)	177.5	7.6
Weight at Admission (Kg)	116.5	20.1
Weight at Discharge (Kg)	105.9	17.8
Time in Program (Weeks)	5.3	2.1

When this article was written, Dr. Griffith was on the staff of the Alcohol Rehabilitation Service, NRMC Long Beach, CA 90822. He is presently Medical Director of the Addictive Disease Unit, Charter Pacific Hospital, Torrance, CA 90505. Mr. Owen, who was on the staff of the ARS, NRMC Long Beach, is now Program Director of the Addictive Disease Unit, Charter Pacific Hospital. LT Marcinik is a research physiologist, Naval Health Research Center, San Diego, CA 92138.

samples were also drawn and analyzed for each patient. Thirty-five variables were extracted from these questionnaires and blood tests. Information included such items as history of obesity, eating patterns, alcohol use, disease prevalence, blood abnormalities, and behavior and psychological problems.

Two steps were undertaken in the analysis of the data. A factor analysis was performed initially using rate of weight loss in the program as the criterion measure. The purpose of the factor analysis was to identify related variables and to determine the extent of these variables' contribution to the total variance. In this manner variables which did not add significantly to the factors were eliminated. A summary of the factor analysis is given in Table 2. A listing of variables making up the factors, the amount of variance accounted for, and the weights given to each significant item for each factor (cutoff = 0.40) are shown.

Multiple regression analyses were then conducted to determine the multiple correlations between variables and weight at discharge with weight at admission held constant. This enabled us to identify which variables best predicted successful weight loss patients and to observe if these variables appear in any particular factor of the demographic, personal history, and health items. This would aid in the understanding and determination of who benefited the most from this obesity program.

Results and Discussion

Factor Analysis. Results of the factor analysis revealed a total of 10 factors that contributed to at least four percent of the total variance (Table 2).

Factor I, for example, was made up of three related variables, age, sex, and height. These variables displayed the highest factor loadings and accounted for 11.3 percent of the total variance. This factor is clearly based on the physical characteristics of the patients.

Factor II was made up of two related variables, age of onset of obesity and teenage obesity. These variables accounted for 9.7 percent of the total variance.

Factor III consisted of two related variables, active service and age, and accounted for 8.5 percent of the total variance.

Factor IV was made up of three related variables, race, number of siblings, and number of obese siblings, and accounted for 8.3 percent of the total variance.

Factor V was based on obesity-related diseases. The two related variables, pulmonary disease and heart disease accounted for 6.8 percent of the variance.

Factor VI was made up of two related variables, alcohol use and civilian legal problems, and accounted for 6.0 percent of the total variance.

Factor VII was based on health problems. The three related variables, hypertension, uric acid, and SGOT/LDH), accounted for 5.7 percent of the variance.

Factor VIII was also based on health problems. The two related variables, abnormal EKG and major surgery, accounted for 5.2 percent of the total variance.

Factor IX was based on the health problem of elevated blood sugar. The variable accounted for 4.4 percent of the total variance.

Factor X consisted of one variable, parental history of alcoholism, and accounted for 4.2 percent of the total variance.

Factor Variable Correlations. The only variables found to correlate significantly with the criterion measure (rate of weight loss) were sex ($r = -.39$, $p \leq .001$), height ($r = .31$, $p \leq .001$), and elevated blood sugar ($r = .19$, $p \leq .05$) (Table 2).

The variables of sex and height are both found in Factor I and display similar opposite directions of loadings.

The inverse relationship between rate of weight loss and sex and the direct relationship between rate of weight loss and height suggests that men were more successful weight loss patients during this particular program. This finding might also be explained by the fact that men enter the program at a significantly greater weight and consequently lose weight at a faster rate than women.

The significant correlation between rate of weight loss and elevated blood sugar ($r = .19$, $p \leq .05$) suggests that successful weight loss patients have more normal levels of blood glucose. Glucose utilization is influenced by various hormones and is drastically decreased when insulin is lacking as in diabetes. Researchers have demonstrated that a good correlation exists between utilization of glucose and the state of hunger or satiety experienced by subjects—a large rate of utilization corresponding to satiety and a decreased rate to the reappearance of hunger. (*12*) Patients with elevated blood sugar levels indicative of decreased glucose utilization may therefore experience enormous appetites that prevent successful weight loss.

Correlations for Adjusted Weight. Table 3 is a listing of significant correlations found between weight at discharge and patient characteristics with weight at admission held constant. The magnitude of the significant correlations ranged from -.18, $p \leq .05$ (elevated serum triglycerides) to .66, $p \leq .001$ (uric acid).

Lower discharge weight, after adjustment for weight at admission, was found to be inversely related to years active service ($r = -.34$, $p \leq .001$) and age ($r = -.53$, $p \leq .001$). These two variables also made up Factor II and contributed 8.5 percent to the total variance. These findings indicate that successful weight loss patients were significantly older and had served a longer period of time in the service. A possible explanation of this finding is that older, more experienced person-

TABLE 2. Summary of Factor Analysis

Factor No.	Variable	Factor*** Loading	% Variance	(Criterion) Adm. Wt.-Disch. Wt. Time
I	Sex	.87	11.3	-.39**
	Age	.68		.01
	Height	-.47		.31*
II	Age of Onset Obesity	.96	9.7	-.06
	Obese as Teen	.81		.05
III	Active Service	.92	8.5	.15
	Age	.88		.01
IV	Race	.63	8.3	.08
	No. of Siblings	.66		.07
	No. of Siblings Obese			.14
V	Pulmonary Disease	-.89	6.8	-.07
	Heart Disease	-.90		-.09
VI	Alcohol Use	-.63	6.0	-.11
	Civilian Legal Problems	.72		-.17
VII	Hypertension	.54	5.7	-.12
	Uric Acid	.51		-.12
	SGOT/LDH	.42		.11
VIII	Abnormal EKG	.81	5.2	.11
	Major Surgery	.46		.10
IX	Elevated Blood Sugar	-.82	4.4	-.19†
X	Parental History of Alcoholism	.69	4.2	-.16

† $p \leq .05$
* $p \leq .01$
** $p \leq .001$
*** Only items with factor loadings (eigen values) greater than .40 are reported for each factor. The factor analysis was done on 29 items for which the N of subjects having data was greater than 115.

nel may be more motivated to lose weight. They have experienced enough "pain" from their obesity to significantly lessen their denial. These patients seem to have made a greater commitment of their lives and a greater investment of time and energy toward their military careers.

The expectation of collecting retirement payments after the completion of 20 years service may have also been a substantial weight loss incentive for these patients. These individuals, therefore, had both more to lose from being obese and more to gain by losing weight than younger, less experienced patients.

Another interesting finding of this study was that discharge weight was significantly associated with parental history of obesity ($r = .31$, $p \leq .01$), number of siblings ($r = .20$, $p \leq .05$), and number of siblings obese ($r = 44$, $p \leq .001$). Factor III, contributing 8.3 percent to the total variance, consisted of two of these variables (number of siblings and number of siblings obese).

These findings appear to indicate that low discharge weight patients come from smaller families with fewer obese family members. The success of these patients during the program may have been due to the fact that cause of obesity was related more to social and environmental factors than to genetically transmitted traits. Perhaps the lower family history of obesity makes these obese patients less refractory to weight loss. These individuals may thus be more responsive to obesity treatment programs in which social or environmental stimuli are manipulated.

Discharge weight was also found to be significantly correlated with eating patterns ($r = .31$, $p \leq .01$) and type of program ($r = .47$, $p \leq .001$). These results suggest that successful weight loss patients can be characterized as stress and nighttime eaters as opposed to being general overeaters or bingers. It appears that general overeaters and bingers may experience the increased appetite associated with decreased glucose utilization and elevated levels of glucose. This metabolic imbalance, characteristic of diabetic patients, may be genetically transmitted and thus extremely hesitant to treatment. Stress and nighttime eaters may have been more successful weight loss patients because certain social and environmental factors were controlled to a degree during the program.

Low discharge weight patients were also found to be more responsive to a specialized obesity treatment program than to a general alcohol rehabilitation program. These patients may have felt obligated to lose weight as a reciprocal gesture for the personalized care and attention they receive while in the obesity program.

Significant correlations were also found between low discharge weight and major surgery ($r = -.31$, $p \leq .01$), elevated blood sugar ($r = -.25$, $p \leq .001$), elevated serum triglycerides ($r = -.18$, $p \leq .05$), abnormal EKG tracings ($r = -.20$, $p \leq .05$), and elevated uric acid levels ($r = .66$, $p \leq .001$). These findings indicate that low discharge weight patients have lower levels of many of the risk factors associated with coronary heart disease. The presence of a

TABLE 3. Coefficients Between Weight at Discharge and Patient Characteristics

(Controlling for Weight at Admission by Partial Correlation)
N > 88

Variable	Weight at Discharge
Active Service (Years)	-.34*
Age	-.53*
Parental History of Obesity	.31**
No. of Siblings	.20†
No. of Siblings Obese	.44*
Type of Program	-.47*
Sibling History of Alcoholism	-.20†
Suicide	.21†
Eating Pattern	-.31**
Major Surgery	-.31*
Elevated Blood Sugar	-.45*
Elevated Triglyceride	-.18†
Elevated Uric Acid	.66*
Abnormal EKG	-.20†

* $p \geq .001$
** $p \geq .01$
† $p \geq .05$

healthy cardiovascular system may have afforded these patients the added dimension of weight loss through exercise.

The high correlation between discharge weight and uric acid ($r = .66$, $p \leq .001$), suggests that the low discharge weight patients were in a catabolic state. Elevated uric acid is indicative of a high protein turnover rate. Elevated catecholamine levels may have been responsible for the high uric acid concentrations. Catecholamines have been found to exert both a proteolytic and lipolytic effect on human subjects and are thus active agents in promoting weight loss.

Conclusion

The major thrusts of this obesity treatment program were to help patients accept their illness, overcome denial and feelings of powerlessness, and develop self-responsibility for their eating behavior. The patients had all previously failed on more traditional weight loss regimens.

The impressive weight loss of patients during this program ($\bar{X} = 10.6$ Kg) suggests that this approach may be the most effective method of achieving weight loss in the massively obese.

The findings of this study suggest that older, more experienced personnel with a lower degree of family history of obesity and in seemingly better health are the most successful weight loss patients. These patients in general had less denial of their obesity and more willingness to follow the treatment program.

Though the massively obese represent a modest percentage of the total obese population of the Navy, findings of this study can be applied to programs directed toward the marginally obese who represent the majority of the Navy's obese population. This large population is an increased health risk for such diseases as hypertension, diabetes mellitus, gallbladder disease, pulmonary dysfunction, gout, and carcinoma. Also obesity as associated with precursors to coronary heart disease include increased low density lipoproteins, and decreased high density lipoprotein cholesterol, hypertriglyceridemia, and increased insulin production. (*10*)

These individuals thus represent a potential financial burden to the Navy in terms of increased hospitalization costs and workdays lost. During the period 1965-1975, 3,065 Navy personnel were hospitalized at least once with a diagnosis of obesity. These personnel were hospitalized for a total of 116,012 days with an average stay of 37.5 days. The largest number of admissions occurred for patients who were in the age group between 17-22 and 35-40 years of age. The highest incidence rate of obesity occurred for the medical group (hospital corpsmen), followed by the deck, administrative and clerical, construction, and engineering and hull categories. (*8*)

To be cost-effective, obesity treatment programs need to be directed toward these specific age groups and occupations. Findings of this study as well as other recent programs (*9*) should be consolidated so that a standardized Navy obesity treatment program can be developed.

In conclusion, this program has demonstrated an effective method for achieving weight loss in the massively obese. It recognizes massive obesity as an illness for which the patient must assume personal responsibility. Group sessions were helpful in breaking denial, which is considerable, and in lending peer support. The patients assumed total responsibility for their eating and received further peer support through OA attendance.

Preliminary long-term followup data also indicated that those patients who continue in contact with OA continue to lose weight and are able to adapt to the psychological stress of loss of body size.

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New Medical Tool for Submarine Corpsmen: Computer Ready for Sea Trials

LCDR Joseph Henderson, MC, USN HMC Richard Post (Submarine Service), USN HMC Mark Decora, USN

George Moller, Ph.D. Bernard L. Ryack, Ph.D. Karen Robinson

At the Naval Submarine Medical Research Laboratory (NSMRL), members of the Human Factors and Environmental Medicine groups have been working to develop a computer-based medical information/diagnostic system for use by hospital corpsmen aboard patrolling nuclear submarines. After five years of development and testing, the system is ready for full-scale controlled clinical trials at sea. This article is partly about the computer and the sea trials. But developing the computer system has involved much more than working with computer hardware and software. It has been important to look to its intended user, the submarine corpsman (NEC 8402), as the one who ultimately determines whether this new medical tool is used or not. This is true for two reasons. First, the computer system's accuracy is *totally* dependent on the accuracy of the information it is given, so it is important that its users be well-trained and well-motivated. Second, a tool is useful only if it is used; the computer system must be designed and presented in such a way that the submarine corpsmen will want to use it. Thus, the most important and key part of the "system" is the corpsman himself.

Dr. Henderson, on the staff of the Naval Submarine Medical Research Laboratory, Groton, CT 06340, is now studying with the Department of Epidemiology, Yale University, New Haven, CT 06510. Dr. Moller is head of NSMRL's Human Factors Department. HMC Post, Dr. Ryack, and Ms. Robinson are with the same department. HMC Decora is with the Environmental Medicine Department.

The Submarine Corpsman

All 8402 corpsmen are senior enlisted men (E-5 to E-7) who have completed training at the Naval Undersea Medical Institute (NUMI) at the Submarine Base, New London. Training at NUMI consists of submarine orientation, as well as courses in administrative procedures, radiation and environmental health, and clinical medicine. Clinical training involves an intensive course in physical diagnosis, laboratory techniques, therapeutic, and practical work rendering clinical care.

The submarine corpsman heads the medical department of a submarine. He also has one of the most difficult jobs held by any health professional. Responsible for the health care of about 130 men, the corpsman must perform under circumstances any clinician, even the most experienced, would find demanding. Diagnostic and therapeutic tools are limited. Taking a medical history and performing a physical examination, manual blood cell counts, and urinalysis are available sources of information; x-rays, blood chemistries, electrocardiograms are not. Perhaps more significantly, because of radio silence requirements of the submarine's mission, outside medical advice often cannot be sought until relatively late or not at all; the corpsman must sometimes make difficult medical decisions without benefit of consultation with other clinicians.

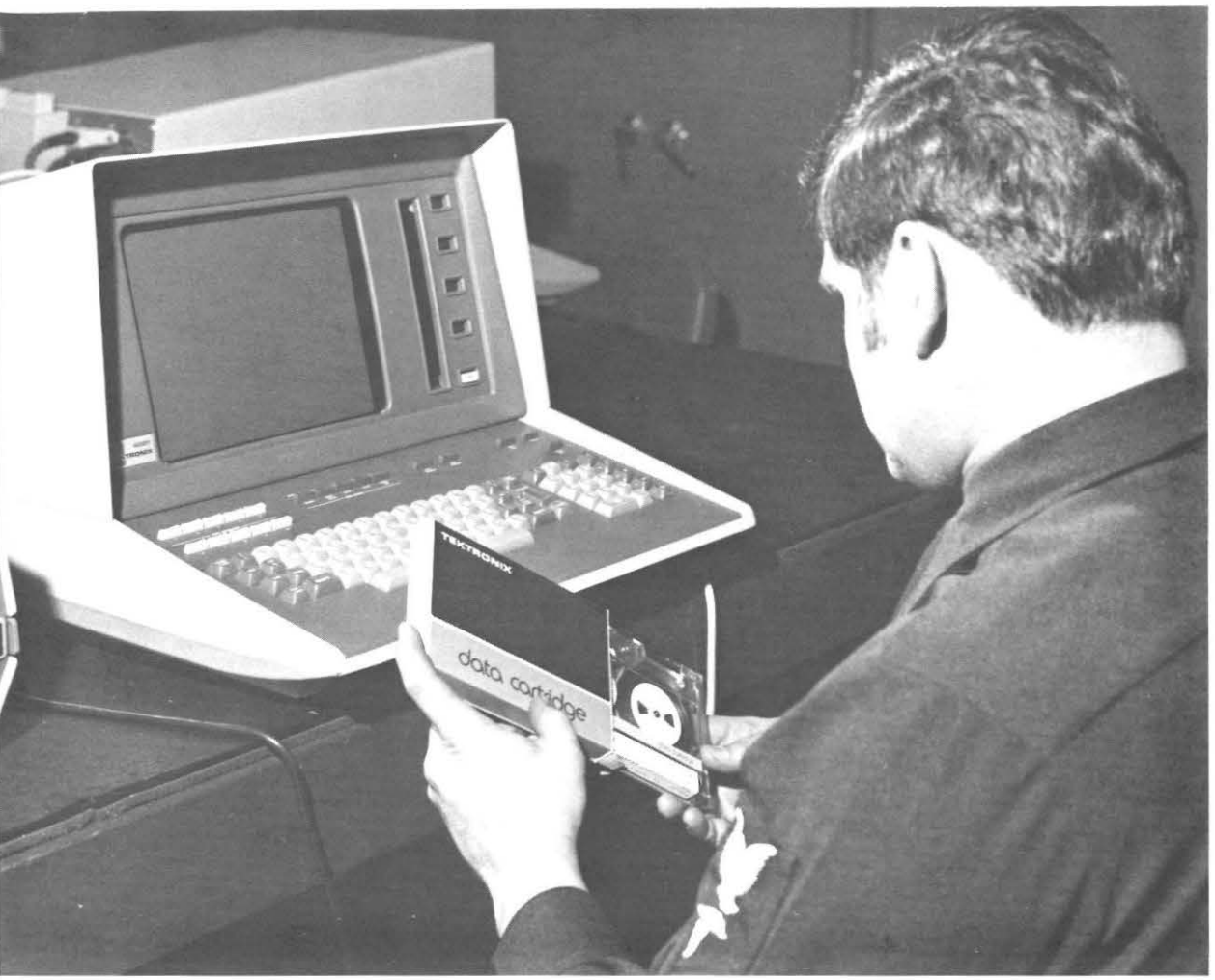
Further compounding the difficulty of his job, a corpsman's medical decisions can have effects beyond those involving his patient. His decisions also can impinge significantly on his submarine's mission. This is especially true when management of a patient requires that he be evacuated to a primary care facility. Because a medical evacuation (Medevac) exposes a submarine's position, its mission can be compromised for a period, a condition that could affect our country's ability to retaliate if attacked with nuclear weapons. Thus, the national defense can be affected by a Medevac.

There are other reasons for making the Medevac decision a careful one. Medevacs, especially in heavy seas, are hazardous to patients and rescuers alike; patients could be drowned and rescuing helicopters could crash during attempts to evacuate. Also a single Medevac can be expensive, sometimes involving movements of large numbers of ships, aircraft, and men.

Thus, the corpsman working aboard submarines, with few tools and without outside advice, must make difficult medical decisions that can affect his patient, his ship, and the defense of his country. It is a tribute to the caliber, dedication, and training of these individuals that they perform these demanding duties competently and effectively.

The Computer

At NSMRL we have been developing an on board, microcomputer-based medical support system to assist the submarine corpsman as a medical consultant and in other ap-



Programs currently in use for the system are provided on two magnetic tape cartridges.

plications. Computer programs will eventually be provided in three main areas: patient management, continuing medical training, and medical department administration. Patient management programs will assist diagnosis, prognosis, and treatment of such common significant problems as acute abdominal pain and chest disorders. Computer-aided instruction will be provided for use while on patrol to support the patient management program, e.g., computer simulation of patients with abdominal pain or requiring cardiopulmonary resuscitation. The administrative duties of submarine corpsmen are very demanding and are increasing. Maintenance of health records, including radiation exposure, reports, and medical supply inventory, are examples that are amenable to at least some computerization.

The present system has programs in each of the above areas: assistance in the diagnosis and management of patients with acute abdominal pain; computer simulation for training purposes of patients with acute abdominal pain; and a program to assist in the maintenance of DD-1141, Record of Exposure to Ionizing Radiation.

The system is currently implemented on the Tektronix 4051 desktop computer, which has 32 Kilobytes of random access memory and a built-in magnetic tape cartridge reader/writer. There is also an associated hardcopy unit which provides copies of the computer's CRT (cathode ray tube) display. This computer is already aboard submarines for other applications and can be made available for the corpsman's use. The programs currently used are provided on two magnetic tape cartridges. Thus, the direct hardware costs in implementing the system are less than $100 per boat.

Since nearly half of Medevacs involve patients with acute abdominal pain, we began our efforts in this area. A review of the literature revealed one computer system with demonstrated clinical effectiveness in aiding diagnosis of acute abdominal pain. The system, developed by deDombal and his associates at the University of Leeds, England, appeared well-suited to submarine use since computer-aided diagnosis is made without laboratory tests, can be implemented on a microcomputer, and has a diagnostic accuracy (91 percent) exceeding that of junior (42

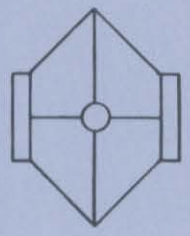
PATIENT NAME: _____ AGE: _____

SSN: _____ DATE/TIME: _____

HISTORY

PAIN

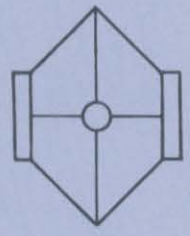
AT ONSET
(most significant when it began)



SITE

(11)	RUQ	(24)
(12)	LUQ	(25)
(13)	RLQ	(26)
(14)	LLQ	(27)
(15)	UPPER HALF	(28)
(16)	LOWER HALF	(29)
(17)	RIGHT HALF	(30)
(18)	LEFT HALF	(31)
(19)	CENTRAL	(32)
(20)	GENERAL	(33)
(21)	RIGHT FLANK	(34)
(22)	LEFT FLANK	(35)
(23)	NO PAIN	(36)

AT PRESENT
(most significant at time of exam)



TYPE OF PAIN:
(at times free of pain = intermittent; constant = steady; constant and varying in intensity = colicky)
INTERMITTENT (37) STEADY (38) COLICKY (39)

SEVERITY OF PAIN:
(do not ask; obvious distress = severe; everything else = moderate)
MODERATE (40) SEVERE (41)

PROGRESS OF PAIN:
(at the time of examination)
BETTER (42) SAME (43) WORSE (44)

DURATION OF PAIN:
(duration of this episode of pain)
12h or less (45) 12-24h (46) 24-48h (47) 48+h (48)

AGGRAVATING FACTORS:
(ask specifically about each; have the patient move and cough)
MOVEMENT (49) BREATHING (51) OTHER (53)
COUGH (50) FOOD (52) NONE (54)

RELIEVING FACTORS:
(ask specifically about each)
LYING STILL (55) ANTACIDS (57) OTHER (59)
VOMITING (56) FOOD (58) NONE (60)

OTHER SYMPTOMS

NAUSEA: YES (61) NO (62)
(feeling sick to stomach)

VOMITING: YES (53) NO (64)
(being sick to stomach)

APPETITE: DECREASED (65) NORMAL (66)
(recent change in appetite)

JAUNDICE YES (67) NO (68)
(history of yellow color to skin or sclera)

BOWELS: *(recent change in bowel habits)*
NORMAL (69) DIARRHEA (71) MUCUS IN STOOL (73)
CONSTIPATED (70) BLOOD IN STOOL (72)

URINATION: *(recent change in urination)*
NORMAL (74) PAINFUL (76) BLOOD IN URINE (78)
FREQUENCY (75) DARK URINE (77)

PAST HISTORY

PREVIOUS INDIGESTION: YES (79) NO (80)
(regular problem in the past)

PREVIOUS SIMILAR PAIN: YES (81) NO (82)
(pain like this before)

PREVIOUS SURGERY: YES (83) NO (84)
(abdominal surgery or trauma - must be intraperitoneal)

PREVIOUS ILLNESS: YES (85) NO (86)
(any pertinent illness, not just abdominal; i.e., requiring hospitalization)

TAKING MEDICATIONS: YES (87) NO (88)
(medication for this pain only)

Data sheet from the abdominal pain program.

percent) and senior (82 percent) clinicians. In hospitals serving two percent of the UK population, use of the computer has been associated with significant decreases in the negative laparotomy and perforated appendix rate, and with shortened hospital stay. The program employs a Bayesian analysis of a data base, constructed from clinical information gathered prospectively from a general population of abdominal pain patients in Leeds, England.

In collaboration with Dr. de-Dombal, this program has been adapted for use aboard submarines. The program has been tailored to the submarine environment by constructing a data base suited to the submarine population (young, healthy males seen within first 48 hours of illness). The NSMRL group also developed supporting programs to generate data collection forms, to supply definitions and instructions, and to make recommendations regarding patient disposition and initial therapy. Curricula and materials for training corpsmen in methods of gathering clinical data and in use of the computer and programs have also been devised in collaboration with the Naval Health Sciences Education and Training Command. As mentioned before, the training of users is extremely important because accuracy of the computer depends entirely on accuracy of data entered. Clinical trials of the adapted system were conducted at the emergency room at NRMC San Diego, CA, using students completing their training at the Independent Duty Technician (IDT) School, Naval School of Health Sciences, San Diego, CA. Young, male patients presenting with previously undiagnosed acute abdominal pain were evaluated by IDT students, who gathered appropriate clinical data and entered those data into the computer. Overall diagnostic accuracy of corpsmen using the adapted program in this series was 72 percent for 132 patients. This can be compared with an unaided diagnostic accuracy of Navy doctors of 78 percent in the same series and of English house surgeons of 72 percent in a different series. A preliminary report of these results has been published.

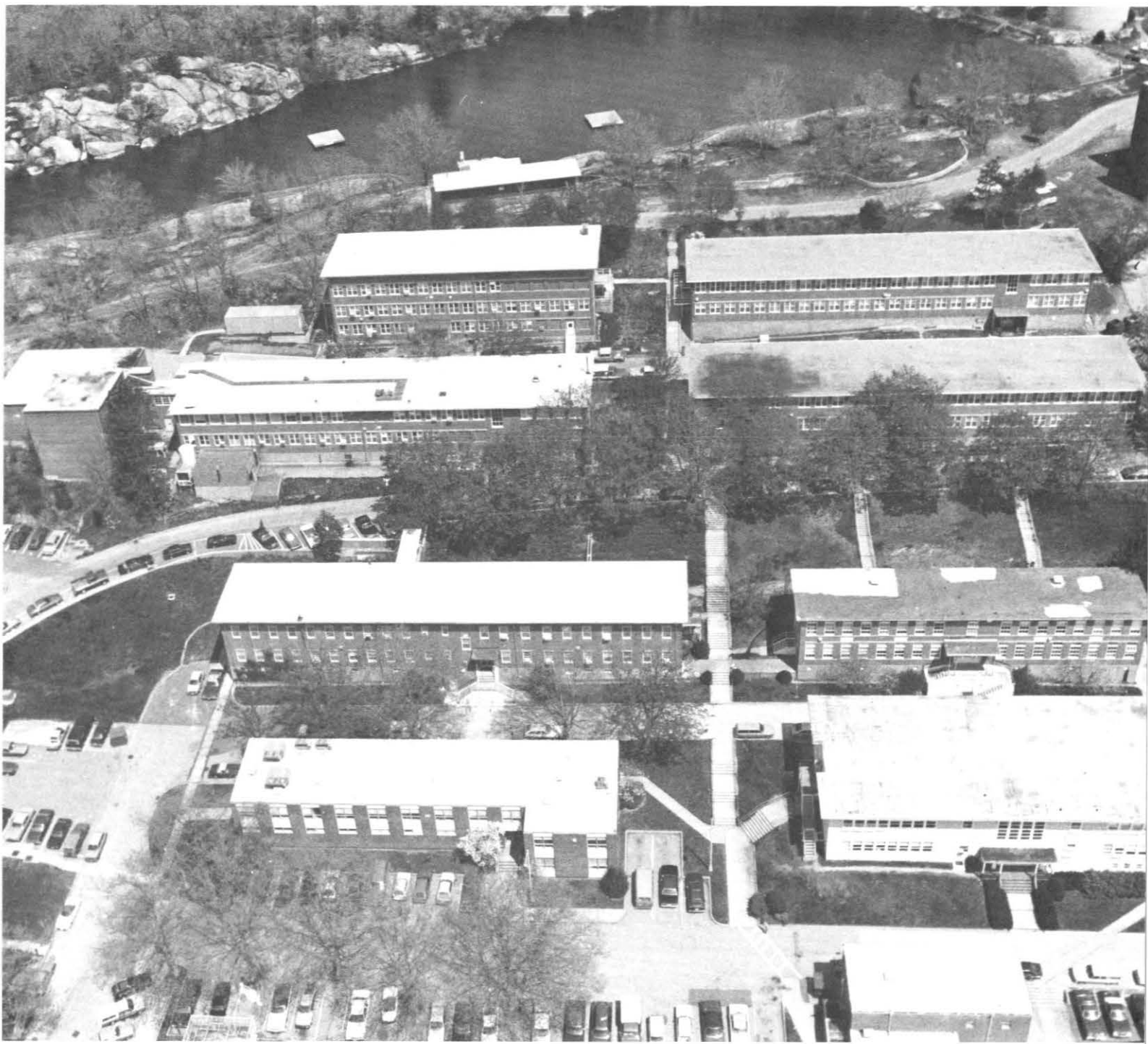
Preliminary at-sea testing was also conducted to test user acceptance and to find whether unanticipated problems might arise during operational use of the system. Participating submarine corpsmen, executive officers, and commanding officers subjectively assessed whether the trials allowed realistic use of the system, whether the system affected the corpsman's professional role or his interactions with his XO or CO, and whether the system was useful in making Medevac or other patient care decisions while at sea. Four fleet ballistic missile submarines participated, each for one two-month patrol. To insure use of the system in a predictable way, preselected submarine crewmembers who were trained to simulate abdominal pain presented to the corpsman for diagnosis during patrol. The corpsmen did not know in advance that a given case might not be real. COs and XOs also participated in each drill as if the patient was genuine, though they knew in advance that the illness was not genuine. At the end of patrol, each corpsman, XO, and CO was interviewed and these interviews were recorded and transcribed in toto. During the study, nine simulated and four genuine cases of abdominal pain were evaluated. In debriefings, all participants stated that the simulated patients appeared genuine and that this method provided for realistic use of the system. All corpsmen viewed the computer as an aid to and not a replacement for their clinical judgment and that the computer was especially useful in insuring a complete and thorough history and physical examination. The corpsmen and the XOs and COs also found the computer programs very valuable in organizing and summarizing patient data and the printouts provided a basis for discussing Medevac decisions. All stated that the computer was useful in making Medevac and other patient-care decisions and unanimously endorsed its use aboard submarines at sea.

Fleet-Wide Testing

It has been shown that the computer system is medically valid and can be a valuable resource to the submarine corpsman. But not enough is known about its clinical and operational impact during actual use at sea. To obtain this knowledge, an operational clinical trial of the system at sea has been proposed. This test will involve most of the Navy's nuclear submarines. All participating corpsmen will be given the forms and trained in gathering the patient information required for its use. Only one-half the submarines will receive the patient management program, the remainder acting as controls. In this way, the trials will determine the influence, over and above training in clinical data-gathering, of a computer system designed to aid medical decision-making.

Perhaps more importantly, the sea trials provide our first opportunity to truly determine whether a medical computer can assist a clinician faced with such an extremely difficult job. The key word is *assist.* The system is not intended as a replacement for a corpsman or his clinical judgment. Rather, it is designed to support, reinforce, and suggest alternatives. But as with any tool, the computer can be used or misused. The attitude and training of users are undoubtedly the most important factors. Very importantly, the computer should be regarded with an attitude of open-minded skepticism; it must be given a chance to assist, but must not be allowed to dictate decisions. Further, to perform well, it must be used by individuals who are well-trained, conscientious, and thorough. It is our experience that submarine corpsmen possess the attitude and qualities needed to properly use this new medical tool □

Photos by W. Abrams



NSMRL buildings at the Naval Submarine Base, Groton.

Lab for the Silent Service

> A submarine's natural habitat is the deep, silent depths of the sea. The deeper she can go, the safer she is, and with the comfortable shelter of hundreds of feet of ocean overhead the submariner can relax. Deep in the sea there is no motion, no sound, save that put there by the insane humors of man. The slow, smooth stirring of the deep ocean currents, the high-frequency snapping or popping of ocean life, even the occasional snort or burble of a porpoise are all in low key, subdued, responsive to the primordial quietness of the deep.*

The deep ocean may, in fact, be the natural habitat of submarines but it is not so for the air-breathing mammals that man them. The undersea environment can be as inhospitable and forbidding as the deep reaches of space. In the confines of a submarine there is no sunlight, no visual horizon, no contact with the outside. A submariner's world is his boat.

When man slips beneath the waves, he still must breathe life-sustaining air and be protected from crushing pressure and numbing cold. Yet the maintenance of life is just the beginning. With today's nuclear-powered vessels, submariners must perform their jobs safely and efficiently, complex duties unheard of just 35 years ago.

During World War II a submarine patrol lasted a matter of weeks; diesel-powered boats could remain submerged only as long as their batteries held out. Today's nuclear patrols last up to three months, much of that time submerged. The fleet ballistic missile subs that form one of the integral legs of this nation's deterrent triad little resemble their forebears either in purpose or appearance. The new 560-foot Trident sub USS *Ohio,* when on station, will carry nuclear-tipped missiles capable of hurling up to 336 warheads at an enemy. Nuclear attack subs, certainly no less sophisticated, are not only crammed with sonar gear to detect enemy targets but weapons to destroy them as well.

Insuring the continuing success of this dynamically complicated marriage between undersea machine and man is the primary task of the 39-year-old Naval Submarine Medical Research Laboratory (NSMRL). The Lab, headquartered at the Navy Submarine Base in Groton, CT, is just up the Thames River from where the first subs in the Trident series are being built. Established in 1942 to solve submarine-related problems concerning vision, communications, environmental medicine, and personnel selection, the Lab's investigators now study biomedical and behavioral problems relating to diving and submarine environments, specifically visual and auditory requirements and performance measurements for sonar operators. In addition, NSMRL is the Navy's principal investigator responsible for cold weather medical research. Today, with a staff of about 100 military and civilian researchers, it is a separate activity under the direction of the Naval Medical Research and Development Command, Bethesda, MD.

Contributions

NSMRL's history over the years is a dizzying record of projects and achievements. As early as 1951, NSMRL showed that men with acuity of less than 20/20 (20/30 or better) could perform adequately, a study that lead to a reduction in visual acuity standards for submariners.

Two years later, researchers demonstrated man's capacity to tolerate the long confinement in elevated levels of CO_2 and established CO_2 tolerance limits for nuclear-powered submarines.

In 1959 scientists conducted the first Department of Defense research that provided guidelines for psychiatric screening of antarctic wintering over personnel.

A year later, NSMRL established the mission duration of fleet ballistic missile subs based on psychological research aboard USS *Triton* during its underwater circumnavigation of the world.

In 1962 researchers conducted the first Navy experimental program in saturation diving called "Project Genesis" and later supplied the direction, personnel, and expertise in the development of the "Sealab" project.

In 1968 NSMRL scientists determined the best colors to use for underwater camouflage and for highest visibility in all types of water and lighting conditions.

In 1972 NSMRL demonstrated that the visual-evoked cortical response was an excellent measure of brain functioning under hyperbaric conditions, thus providing an objective measure of the adaptive conditions of a diver at a given time. The Lab's scientists, the same year, demonstrated that in some antisubmarine warfare situations, performance of a human plotter is superior to that of certain automatic systems.

Between 1977-1979 the Lab prepared or implemented programs for the diagnosis of 56 common and acute diseases, acute abdominal pain, orthopedic diseases, and chest pain on several mini and microcomputers, including those already aboard submarines. Closely related to this research is the computer-based medical diagnostic/information system for use by corpsmen aboard submarines (see page 6) presently undergoing sea trials.

*Edward L. Beach, *Run Silent, Run Deep,* Holt, Rinehart and Winston, New York, 1955.

Man and Machine

"None of this work has to do with a piece of machinery standing alone," says CAPT Robert Margulies, MC, NSMRL's former commanding officer.* "It is the interaction of the equipment with the human being that's significant." Indeed, nearly all the research the Lab performs seeks to measure with precision and reliability man's ability to perform in the submarine or diving environment. The introduction of more sophisticated hardware has merely complicated the equation and put more rather than less responsibility on those that must man the submarine navy. More and faster Soviet subs have to be located and identified with sonar equipment that can simultaneously track many targets. During

Subject performs color descrimination test during saturation dive.

*CAPT W.C. Milroy, MC, relieved Dr. Margulies in August 1981.

A sonar test is performed in one of NSMRL's simulators.

A subject diver prepares for a test of the portable recompression system.

World War II a sonar set was audio only, but progress brought the video displays. However, in certain instances the human ear still takes precedence, especially when a submarine operates in a high traffic area like the Mediterranean. A sonarman must be able to sort out and identify targets, some of which may be moving on the same heading. A video display might show one contact and the human ear two. "It's like listening to an orchestra," points out Paul Smith of NSMRL's Auditory Department. "Different instruments may be playing the same tune, but you can tell they are different. If you are a trained musician you can even tell that one is an oboe and the other a clarinet."

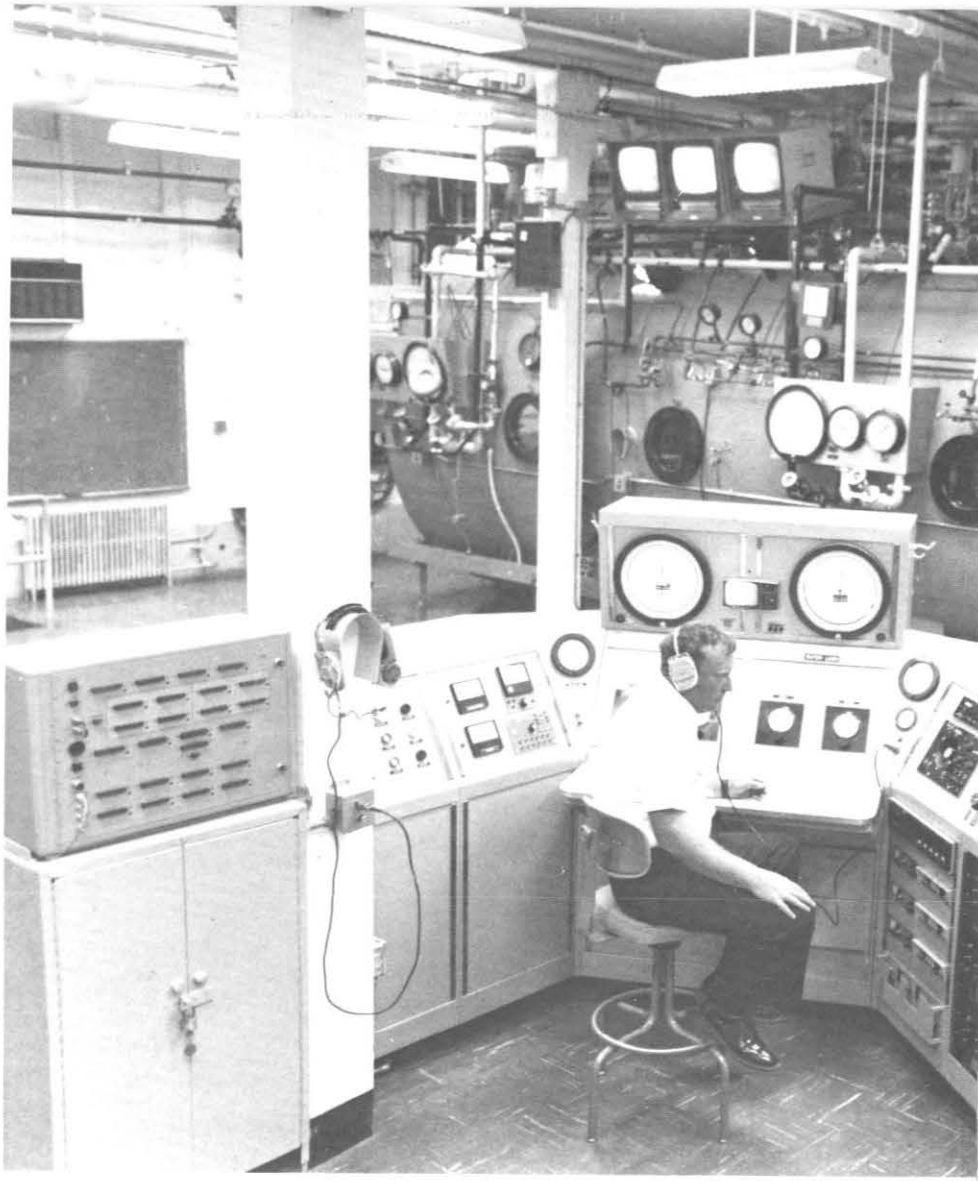
The Undersea Workplace

Heaping more tasks upon a crewmember like the sonarman is possible with no degradation of performance only if that man's working conditions can be improved. Again, because the man-machine union is of paramount importance, all seven of NSMRL's departments have a hand in modifying the submarine environment.* Presently, the Vision and Auditory Departments are seeking to improve the sonar shack by developing new ways to extract usable data from background noise.

*The departments are: Environmental Medicine, Physiology, Biochemistry, Auditory, Vision, Human Factors, and Psychology.

The sonarman's video displays are also undergoing intensive study. What color light is easiest on the eyes yet readily recognizable?

And speaking of light, how does the lack of sunlight affect the submariner's ability to synthesize vitamin D, an important ingredient in calcium metabolism? And how does the lack of exercise affect this process? The Lab's recent cooperative study with the Brookhaven National Laboratory and Massachusetts General Hospital has helped answer both questions. Although circumstantial evidence indicated that there was a change in bone structure after a long cruise, the study showed that once the submariner returns from his sunless environment, vitamin D



Hyperbaric chamber and control console

levels rise and there is no discernible loss in bone structure.

As with the bone study, NSMRL cooperates with other research institutions in its efforts to improve the submarine environment. One study being conducted with the Department of Epidemiology at Yale University is using modern statistic-gathering techniques and large numbers of subjects. Such a study has never before been possible because of the nuclear navy's youth. Says physiologist CDR Ken Bondi, MSC, "It wasn't until 1980 that we began getting those 20-year career men who were entering their 50s and 60s."

As in most research situations, answers inevitably breed more questions. One question of particular interest is the effect long-term exposure to low-level gaseous contaminants has on submariners, particularly carbon dioxide. Submarine crewmen inhaling a CO_2 concentration of less than 0.1 percent seems to have no ill effects, but long-term exposure must be considered when the normal intake of this gas for non-submariners is 0.03 percent. Also undergoing scrutiny are the submariner's inhalation of other trace gases and metals.

A physiological and environmental study of the submariner's workplace would not be complete without a look at a problem common to most naval vessels, especially submarines—exercise. How can a submariner stay fit in such cramped quarters? Exercising is a major problem, admits Dr. Bondi. Some crewmembers will exercise no matter what, down between the missile tubes or on ergometers when they are available. However, given the space constraints, running in place quickly becomes boring shortly into a 70-day patrol, except among the most hard-core fitness buffs. "We have to give the men something novel, something that will hold their interest," he says. Dr. Bondi and his colleagues in NSMRL's Physiology Department are hard at work to develop such a regimen.

Cold Weather

Visitors to NSMRL often ask how the Lab became involved in cold weather research. After all, what does the arctic environment have to do with submarines or Navy diving? The answer is incorporated in NSMRL's official mission: "To conduct medical research and development as it relates to submarine, shipboard, diving and *amphibious* environments . . ." The Marine Corps, by definition, is amphibious and must be prepared to operate as efficiently in Norway as it would in the Persian Gulf. And the researchers at NSMRL readily admit that working and fighting in the cold is a subject our Scandinavian allies know far more about than we do. This nation's last conflict was fought in the jungle and before that there are the bad memories of what the Korean winter did to our fighting men in that conflict.

NSMRL bases its cold weather research on lab work under controlled conditions and actual data-gathering from the field. Cold weather operations generate significant questions, not the least of which is dehydration. How much water does the body require in a cold environment? In the cold, thirst is not evident and an indi-

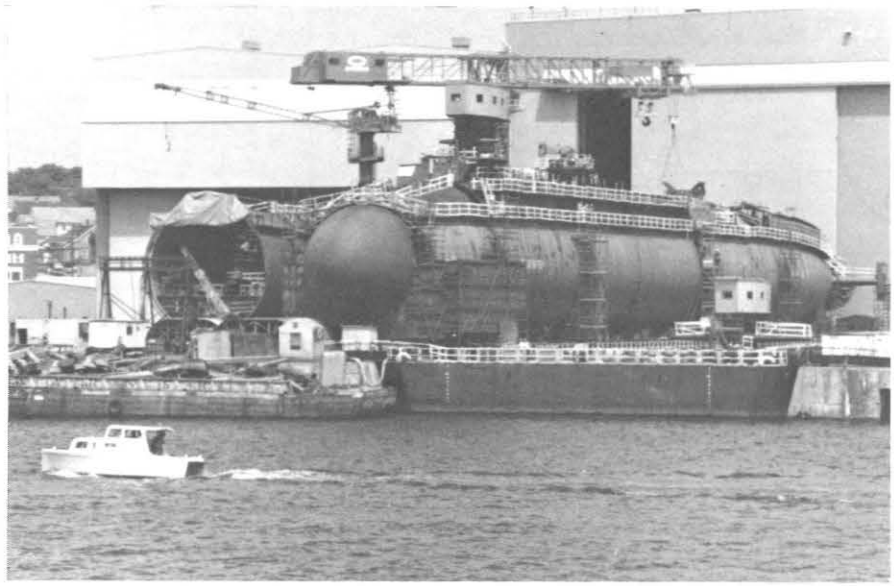


Photo by the Editor

Hull of Trident submarine nears completion at the General Dynamics Electric Boat Division in Groton, CT.

In NSMRL's anechoic (without echoes) chamber, a manikin is used to study engineering specification for optimum auditory classification/detection through headphones.

vidual often has to be reminded to drink.

The Lab has recently conducted a series of experiments at the Army's cold chamber at the Natick Research and Development Laboratories, Natick, MA, in an effort to establish a water requirement for the Marine Corps. Two groups of 18 Marines spent two weeks, one week for each group, in a 15 x 65-foot cold chamber in which the temperature had been lowered to -5° F. The Marines, with full packs, physically worked out on a treadmill to simulate field conditions. Their food and water intake and waste output were carefully monitored. The data from this experiment are still being evaluated and, when the results are in, the Marine Corps

Marine volunteer subjects in the climatic chamber at the U.S. Army Research and Development Laboratories, Natick, MA, take part in a study to determine water requirements in cold weather operations.

will have its new water standard.

Another problem the Lab is examining is that of manual dexterity in the cold. Can a corpsman render effective aid to a wounded comrade at -20° F? Removing his gloves to suture a wound results in numb, ineffective fingers. Moreover, adhesive tape will not even stick at that temperature. Investigators compared the performance of Marines working in the cold for five days to the performance of those that did not. All the answers are not yet in but several solutions to the dexterity problem are being considered, one a redesign of the cold weather medical kit. More questions inevitably beg answers. By practicing tasks in the cold can an individual adapt to that environment and, if not, can those tasks requiring manual dexterity be performed differently?

Vision is a significant problem in the cold and NSMRL is conducting extensive research in this field. Snowblindness, whiteout, conjunctivitis are all vision problems associated with cold weather operations. How can the eyes be protected from ultraviolet, infrared, and reflected light coming from the snow, and how can visibility be improved? Protective eyewear is what the researchers are concentrating on—goggles that will not only protect the wearer but enable him to distinguish objects and improve depth perception, essential requirements when operating in the cold.

Another cold weather study has to do with the effects of the freeze-thaw cycle on pharmaceuticals. Great temperature ranges not only cause breakage of containers but may affect chemical stability as well. Presently, pharmaceutical manufacturers do not have adequate data and collecting it has fallen to NSMRL's cold weather experts.

NSMRL's varied responsibilities continue to make it one of the busiest and most productive research centers in the Navy. As long as sailors must go beneath the sea in ships and diving suits, and the Marines must be prepared to fight in the cold, NSMRL will have more than enough work to keep its scientists occupied.

—JKH □

Deep Sea Rescue

No scenario is more terrifying than that of a damaged submarine lying helpless on the sea bottom, its crewmembers left to die a slow, suffocating death. Although such accidents are not frequent, our growing submarine force increases the likelihood of such an event.

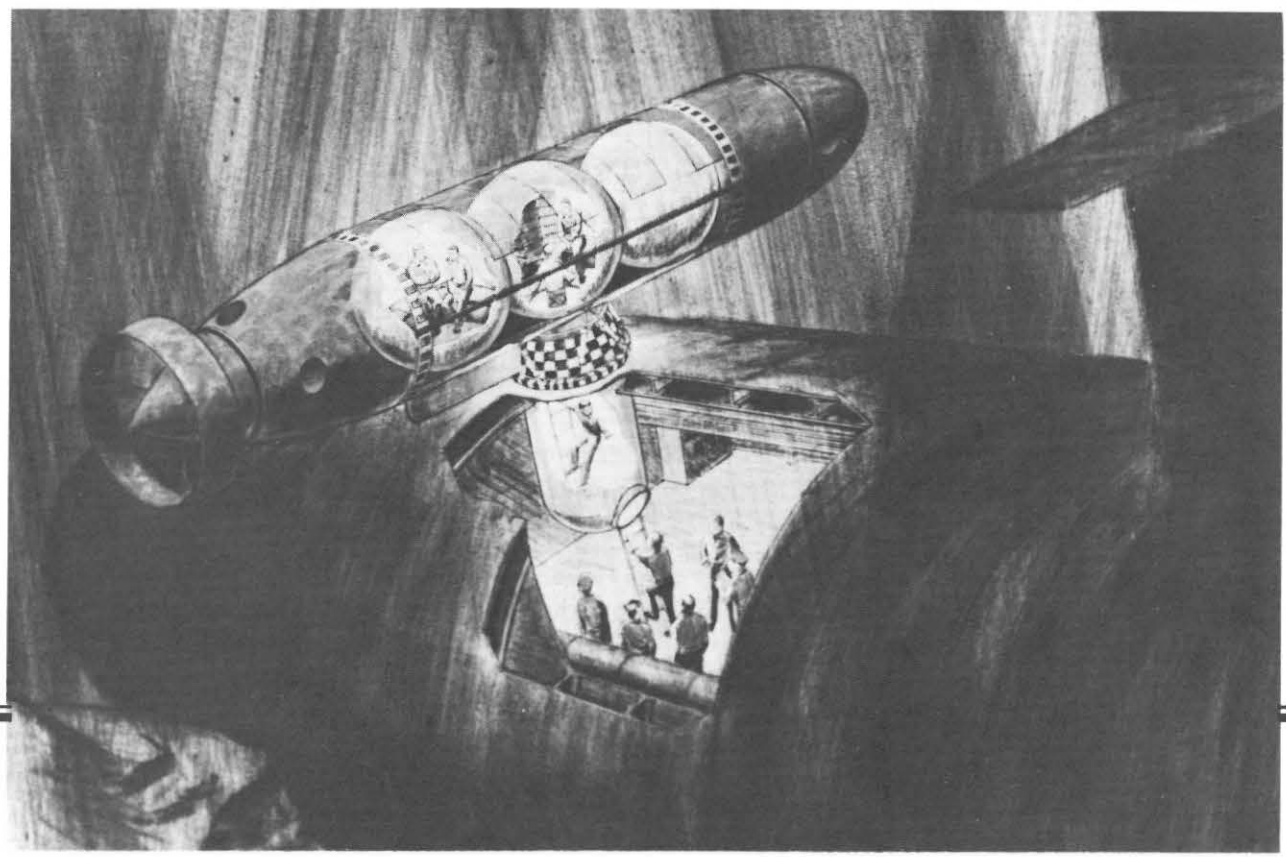
Fortunately, there now is an operational rescue system capable of rescuing the crew of a disabled submarine. The Deep Submergence Rescue Vehicle (DSRV), a 49-foot-long submersible capable of being transported worldwide by land, sea, and air, can operate independently of surface conditions at depths to 5,000 feet. This vehicle can, with its support crew, be rushed anywhere in the world by C-5 military aircraft, transferred to a staging port where it can be mated to a mother sub, and then transported piggyback to the accident site. Once on station, the DSRV can mate with the sunken sub and remove 24 crewmen before returning to the mother ship. Nine round trips are required to evacuate an entire crew.

What to do until help arrives is the scope of the diving research now being conducted by NSMRL's Environmental Medicine Department. A distressed submarine resting in relatively shallow and accessible water most likely will be at least partially flooded. The introduction of seawater or pressurization by other means will subject the crew to a hyperbaric environment for up to the 48 hours necessary for a DSRV to arrive.

A hyperbaric environment generates several problems. Oxygen at increased pressure is toxic and if breathed for long periods can cause irreversible lung damage. A submarine breathing environment consisting largely of oxygen and nitrogen and pressurized to five atmospheres for several days can cause death. Investigators are currently studying the effects of breathing this pressurized atmosphere. Most hyperbaric or saturation diving in the Navy is conducted with a helium-oxygen mixture and the effects of this atmosphere are well-documented. The compressed air atmosphere is largely an unknown quantity. Will the stricken submariners experience nitrogen narcosis and be unable to work toward their own survival? Will they adapt to narcosis? Once they are rescued, how will decompression be accomplished?

NSMRL is hard at work on these problems. Only when they are solved can deep sea rescue truly be a routine operation. —JKH

DSRV mated to a disabled submarine



On Growing Children

Drug Treatment of Hyperactivity: An Ethical Controversy

CDR Eli Breger, MC, USNR

"No great advance has been made in science, politics or religion without controversy." Beecher

Increasingly, more children are being treated with medication for a behavior pattern characterized by overactivity, distractability, short attention span, learning difficulties, and aggressive, impulsive, and disinhibited functioning. This clinical pattern reflects the results of a variety of conditions. It has paraded under a few simplistic labels which have become popular such as "hyperactive child," "hyperkinetic syndrome," and "minimal brain dysfunction" to name the more common. The drug industry and the professions of psychiatry, pediatrics, psychology, and education have disseminated facts, opinions, and misconceptions contributing to parent awareness of this behavior complex.

Pharmacologic Control

Starting in the late 50s and continuing with increasing crescendo, children have been given medication in an attempt to modify the difficult behavior described above. Although precise statistics are difficult to ascertain, it is believed that in sophisticated urban settings as much as two percent of the elementary school age population is receiving such medication. In times past, sedatives were occasionally used. In more recent years a different group of medications has shown far greater specificity and effectiveness. A small measure of the present controversy results from the fact that these medications are pharmacologically classified as "stimulants" when administered to adults. It has long been known that stimulants given to growing children have a paradoxical effect in that they tend to calm and inhibit activity levels rather than enhance them. If the medicine is effective, one sees a decline in activity, a lessening of distractability, a lengthening of the attention span, and greater control over impulsivity making the child more manageable. Many studies have shown that even where the medication is not specifically effective, or if one uses a placebo, teachers and parents report a positive effect based on the powerful force of expectation. Therefore, it is not surprising that people call for, demand, and often receive such medication from physicians even where its prescription is not properly indicated.

Sociologic Considerations

It is of considerable interest that physicians of a generation ago, often our own mentors who were every bit as clinically astute as we, failed to mention such a condition in their writings and textbooks. The symptomatology is certainly described but it was considered to belong to a wide variety of dissimilar adjustment problems. Has a new medical disorder been discovered or are we seeing the birth of a sociologically determined entity?

Several factors play roles in the rapid ascendance of considering these behavior patterns as disease entities. From the late 1950s and continuing to the present, we have seen the development of unique and powerful pharmacologic substances used to ameliorate psychiatric disorders with a continued commitment to use them. During this time, society's expectations for children to accomplish academically have increased. On another level, as part of suburban development and life, homes and schools are relying less and less on traditional rules and regulations. They are moving toward a freer, more liberal, democratic, and oftentimes permissive atmosphere, thereby enhancing overstimulation and weakening self-control. Cultural change has occurred so rapidly that it has been difficult for the professions

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involved to develop a rational, balanced, scientifically studied, and time-tested approach to deal with the complex problems of overactivity. At this juncture, it would appear that problems of overactivity have increased due to sociologic reasons, that there is greater capability for pharmacologically controlling them, and greater societal pressure to do so. There is, however, a discrete group among these children who constitute a newly described medical entity shortly to be elaborated upon.

Fundamental Questions

The controversy emerges as more complex. Sensitive, discerning, and probing minds raise vital questions.

- Is the child the problem or is it adult society with its dislike and low threshold for the very types of behavior these children manifest?
- Is the child's personality being altered and controlled and, if so, is it ethical and moral to do so?
- Does the child have rights of his own? Should we obtain an informed consent from the child before placing him on medication, particularly if he is somewhat older?
- Are we engendering hostile and negative feelings within the child by placing him on behavior-altering medication without his approval?
- By placing a child on medication are we depriving him of learning new coping and adaptive techniques which, with time and strengthening, would allow him to control his behavior and better prepare himself for the future?
- Should the physician use more conservative means to help the child learn to adapt and the parents to better understand their child, modify their expectations, and behave in a manner most beneficial to the child's growth?
- Are we providing the child with an addictive model when we give him behavior-modifying medications? May he then learn to rely on other drugs in later years rather than learn to rely on his own ego-adaptive resources?
- Are physicians who treat these symptoms performing the classical medical role of alleviating discomfort or disease, or are they unwittingly assuming the role of society's agents for behavior control?

Resolution of the conflict and emergence from this moral morass rely heavily on a more penetrating understanding of the symptom complex and a call for more astute clinical assessment of the child and his family. Only those children who present evidence of neurologic dysfunction should be placed on stimulant medication. Far too many overly active children are incorrectly diagnosed as having "minimal brain dysfunction." There is inadequate evaluation, differential diagnosis, and classification of the type of overactivity. A thorough evaluation requires time, considerable interviewing expertise, neurologic examination, laboratory studies, and psychological testing. This extensive evaluative procedure coupled with clinical experience allows one to identify those in whom there is strong evidence of neurologic dysfunction. Only these children are prime candidates for prudent stimulant drug management as they suffer from the hyperkinetic syndrome. Overactivity in those who do not show positive physical findings reflects a host of neurotic conflicts, environmental stresses and insecurities, lack of adequate socialization training, or a combination of these factors. Such medication should not be prescribed for these children. When they are improperly placed on stimulant drugs they often do not respond in the desired direction. Our efforts should be directed toward correcting the life stresses they face. Pharmacologic intervention using other drugs may prove helpful here too as part of a total therapeutic program. This diagnostic differentiation becomes more complex as secondary emotional difficulties often develop in neurologically impaired children. These problems result from repeated academic and social failures and conflicts emerging from their inability to control themselves.

Diagnosis of Minimal Brain Dysfunction

The concept of "minimal brain dysfunction" has only recently evolved and needs considerably greater study and research. It is felt these children have an imbalance between the excitatory and inhibitory pathways within the nervous system reflecting either developmental abnormality or subtle or frank injury before, during, or after birth. This information is elicited through careful interviewing and checking of birth records. Development during infancy reveals overactivity usually from very early, nonsmooth patterns of eating and sleeping and uneven development of motor and language milestones. Interviewing would fail to reveal any primary child-mother relationship disorder having occurred early in life. The overactivity continues and intensifies with developing motility in the child and increased socialization demands by the environment, especially at the start of school. Physical examination usually reveals positive neurologic findings often of a subtle type and involving complex coordinative skills referred to as "soft signs." The electroencephalogram is normal or may reveal immature patterns characterized by slow waves characteristic of a younger child. Psychological testing is of help and quite often reveals a "scatter" in the scores of the subtests comprising the intelligence test with weakness in perceptual motor skill areas.

The plight of such children and their families can be most pitiful with a negative spiraling should help not be forthcoming. It is observed that hyperactivity tends to lessen with age as the nervous system comes into better balance. By adolescence it

usually ceases to be a problem. This is generally but not invariably true; there may have developed many secondary emotional problems and these then become far more powerful than the original condition as they usually continue even after the hyperactivity has lessened. A program involving drugs, counseling, and appropriate schooling usually would allow a child to improve and blend back into the normal stream by adolescence.

Pharmacologic Management

It would appear to this physician that appropriate pharmacologic management, using the lowest effective dosage, plays a significant role in managing hyperactivity in a child whose problem, after extensive interviewing, workup and study, is found to have its basis in neurologic imbalance. Quite often drugs are discontinued during weekends and summer holidays. The child is under less stress then and parents are under less pressure and can work with him more assiduously. It also mitigates against the slight degree of physical growth retardation one occasionally sees with long-term use.

Appropriate psychologic counseling for the child and parents as well as adjustment of the school program is equally important. If the drug is effective, the child will gradually be able to develop his ego and cope with life around him because he will no longer be at the mercy of his ruthlessly overactive internal motor. He then can devote attention and energy toward his environment.

When prescribing medication for a child of reasonable age, the physician should explain why he is prescribing medication and its effects. The child's cooperation should be sought. If he is resistant, it would be wiser to be patient, establish a relationship with the child over time, and prescribe when readiness emerges. A resistant child who fights medication tends to undo the beneficial effect of the substance acting on the central nervous system. Some knowledgeable children, as their parents, fear addiction to these stimulants. It is reassuring that no convincing examples of this have ever been reported.

The overriding and imposing need is for a studied, clinically astute, and judicious use of these medications when the terrain has been adequately prepared.

"Ethics is the science of human duty." Swing □

Correction

In the annual roster published in U.S. Navy Medicine, October 1981, USNAVREGDENCEN, YOKOSUKA, JA . . . CO CAPT J.E. CARR, MC, USN, should read USNAVREGMEDCEN.

Pericoronitis: A Diagnostic Scapegoat

CAPT Roger E. Alexander, DC, USN

Third molars are undoubtedly the most maligned of all teeth. On one hand, health critics claim they are removed without sufficient cause. (*10*) On the other hand, they are often unjustly condemned as the cause of a wide variety of problems, including vague pains, orthodontic relapses, anterior tooth crowding, etc. Wisdom teeth are often identified as the source of symptoms simply because they are present. In the arena of overwhelming patient numbers, time shortages, and hasty screenings, third molars may become diagnostic scapegoats, for referral.

Even when the diagnosis of pericoronitis is legitimately made, often the treatment plan becomes overly conservative, resulting in multiple clinic visits and many lost man-hours. This article reviews the clinical criteria for proper diagnosis of pericoronitis, and outlines the author's protocol for expeditious management of such cases.

Etiology

Pericoronal infections occur primarily in adolescence and early adulthood, with a decreasing incidence thereafter, accounting for the relatively high incidence in recruit center clinics. Cases are frequently associated with lowered systemic resistance developing concurrently with upper respiratory infections, flu, viral gingivostomatitis cases, etc. The partially erupted teeth are constantly bathed in a bacterial solution and the warm, moist, dark, protected environment below the operculum provides an ideal incubator for accelerated growth when the missing element—food debris—is added. This, in turn, invokes an inflammatory response, causing, among other things, edema of the overlying tissues. These tissues can then become traumatized during mastication, swallowing, and/or talking, if supererupted or malposed maxillary third molars impinge upon them. Allowed to continue, the localized infection can spread to contiguous fascial tissues, eventually progressing to osteomyelitis, facial cellulitis, and, in isolated cases, even a life-threatening infection.

Bacteriology

The microorganisms causing pericoronitis generally reflect the host's own flora. Like most odontogenic infections, the majority of them are anaerobic, (*2,3*) with four to seven different aerobes and anaerobes involved in the average infection. (*3*) In a study of 31 patients with various odontogenic infections, one case was sterile, while 52 percent were mixed infections involving both aerobes and anaerobes. (*2*) In another study of more than 200 infections, not necessarily pericoronal, staph and aerobic gram-negative rods were not common, and the anaerobic flora were varied. (*3*) Archer, on the other hand, suggests that fusiform bacilli and spirilla are common pathogens. (*1*)

Differential Diagnosis

The diagnosis of pericoronitis is very specific and should not be difficult to make, although sporadic cases may pose diagnostic challenges. Specific signs and symptoms are usually present, including the *classic signs of inflammation.* A partially erupted mandibular third molar is often involved, but the condition has been observed in fully impacted teeth, which communicate with the oral cavity. (*7,11*) Overlying tissues will appear reddened, edematous, and be painful to light palpation. Digital pressure may produce food debris or purulent exudate from beneath the flap. Margins may occasionally appear similar to necrotizing ulcerative gingivitis (NUG). (*1*) The patient may or may not have fever and malaise, depending on the degree of acuteness or chronicity. Trismus, cervical lymphadenopathy, and/or dysphagia may also be present, and patients often seek attention for sore throat or tonsillitis first, both which can accompany or precede a pericoronitis. (*6*) Maxillary third molar pericoronitis, while possible, is very uncommon.

Among the conditions that have been misdiagnosed as pericoronitis are cases with maxillary sinusitis, masseter muscle spasms, MFPD syndrome of the TMJs, Eagle's

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(styloid-stylohyoid) syndrome, tonsillitis, aphthous lesions, ASA and cotton roll burns, viral gingivostomatitis, NUG, cervical lymphadenopathy, upper respiratory infections, pharyngitis, and normal periodic eruption discomfort.

To arrive at a proper diagnosis, the art of history-taking must be exercised, coupled with careful clinical exam, eventually arriving at a final diagnosis based on the specific findings. A clinician failing to fully practice this art may get lost in the philosophical world of "It exists, therefore it is. A third molar is present . . . the patient has pain . . . ergo, the third molar is causing the pain." Closer questioning and listening might derive information from the patient, however, that would change the diagnosis to a rather classic case of sinusitis, or tension-related muscle spasms, etc.

Careful examination of adjacent tissues should be included in the workup. In an illustrative case, the patient pointed to the mandibular third molar area, stating the pain was "right there." Superficial examination revealed a partially erupted third molar, but the tissues were not reddened, nor edematous, and no exudate was present. The diagnosis of pericoronitis was made and the patient was referred for extractions. A more meticulous exam would have revealed the aphthous lesion in the depths of the adjacent buccal vestibule, accounting for the symptoms.

Treatment Considerations

The management is partially based on the clinical judgment regarding the eventual disposition of the involved tooth/teeth. If retention is desirable, for continued eruption into function, conservative therapy may cause remission of symptoms. If removal is indicated, then treatment considerations are correlated with that expectation.

Tooth removal in the presence of acute or subacute infection is controversial. Many clinicians endorse a conservative approach, waiting for acute symptoms to subside. (*1,5,8*) Others favor aggressive surgical intervention under appropriate antibiotic coverage. (*3,4*) The arguments against early intervention are largely based on pre-antibiotic era protocols and the dramatic, but isolated, cases where life-threatening complications have occurred. (*4*) Improved culturing techniques and expanded antibiotic usage, have led to more favorable outcomes and fewer serious complications. (*3*) Moose and Marshall state "the philosophy of never extracting a tooth in the presence of an acute infection has long been abandoned . . ." (*6*)

Often, early removal of an offending tooth will provide the best possible drainage, remove the etiologic factors, and aid resolution of the incipient cellulitis. Such patients must be protected by adequate antibiotic blood levels, normally penicillin, unless allergy is a factor. Some recent discussions have suggested that, in certain odontogenic infections, treatment could be rendered with more conservative antibiotic usage, allowing normal body defenses to manage the local factors. (*9*)

Delaying surgery may permit a more extensive infection to become established, (*6*) resistant bacterial strains may emerge, the patient's discomfort is prolonged, and additional man-hours are lost. In certain military situations, e.g., recruit training, impending ship's movement, etc., such man-hours may seriously compromise the military situation.

A study involving 761 patients in whom impacted third molars were removed as primary treatment for acute pericoronal infections resulted in no complications requiring hospitalization and very few minor sequelae overall: four developed submandibular abscesses, 2 percent intraoral abscesses, and 9.6 percent postoperative trismus. (*4*) The author noted that the results were comparable to another unpublished study involving chronic pericoronitis and concluded there was no difference in the sequelae whether the pericoronitis was acute or chronic. (*4*)

In another study, 1,376 extractions were performed in the presence of acute infection, including 327 cases with fascial space involvement, and no serious postoperative complications were observed. (*5*) The authors felt that early extraction was desirable and important and cite additional references to further substantiate that viewpoint.

The concensus derived from the contemporary literature is that the fear of extracting teeth in an area of acute or subacute infection is unsubstantiated in the physiologically uncompromised patient (i.e., normal defense mechanisms), who has been appropriately covered with antibiotics. This does not advocate careless or thoughtless management whereby teeth in areas of infection are traumatically removed and minimal postoperative followup carried out. Rather, that it is therapeutically permissible for experienced practitioners to manage surgically the selected patients with appropriate antibiotic coverage, cognizant of the potential complications and executing close postoperative followup.

Additional studies are needed to determine whether multiple antibiotic experiences for repeated episodes of pericoronitis predispose the eventual surgery sites to an increased risk of involvement by resistant microorganisms. The author is not aware of any studies exploring this theoretical possibility.

Local Anesthesia and Infections

Clinicians have expressed concern over the advisability of using local anesthesia in these cases. Jorgen used locals in 96.7 percent of the cases in his series, and discounts the admonitions against such usage. (*4*) This is usually not a problem in the mandible unless the patient

has severe trismus since the inferior alveolar nerve block (or Gow-Gates block) is normally used. Since the effectiveness of local anesthetics is pH-dependent, it is theoretically possible that depth of anesthesia might be compromised if pus is present on the medial side of the ramus. There does not appear to be any risk attendant to the administration of the local anesthetic not present from the surgical procedure itself.

Steps for Diagnosis and Definitive Treatment

History. The history will give useful hints regarding possible etiologies through questioning on the timing, character, and location of symptoms. Concurrent medical problems, medication usage, similar past episodes, environmental and situational circumstances (e.g., stress), etc. must all be correlated with this information.

Clinical Exam. Careful examination will normally delineate the precise location of the pain, although occasionally patients can be vague. The presence or absence of palpable tenderness, muscle spasms, trigger zones, lymphadenopathy, tonsillitis/pharyngitis, or adjacent ulcerations should be determined. The overlying operculum should be examined for induration, edema, reddening, ulceration, or exudate, and the patient observed for signs of dehydration.

A most important step in this evaluation is the taking of the body temperature. The oral thermometer is perhaps one of the most neglected diagnostic tools in our repertoire. The direction of the treatment plan is largely predicated on the presence or absence of a temperature elevation. The temperature should always be taken in cases of suspected infection, yet many clinicians never monitor this important vital sign. The results must then be correlated with the historical and clinical information gathered to rule out factors such as dehydration, concurrent systemic problems, e.g., pneumonia, phlebitis, etc., medication side effects, etc.

Radiographs. Appropriate radiographs are ordered as indicated by the history and exam. Depending on the circumstances, these might include a single periapical film, a panographic film, or perhaps extraoral views. The panographic view has advantages because there is no patient discomfort involved in shooting the film, and it provides information on adjacent factors, such as maxillary third molars, etc.

Initiate Treatment. The treatment regimens are based primarily on whether:

- the tooth/teeth will be retained or removed,
- the patient's temperature is elevated or normal, and
- systemic factors are present (malaise, etc.).

Although not foolproof, the presence of a normal temperature (98.6°F $\pm$ 1°, orally) suggests that the body defense mechanisms are containing the local situation and local therapy will usually be adequate to cause remission of symptoms. Local therapy starts with liberal irrigation of the area with a solution of preference or availability, using a bulb syringe, Kelly flask, or a blunted 18 guage needle on a 10-20 cc disposable syringe. Possible irrigating solutions include dilute solutions of Povidone-Iodine (Batadine ®), 9-Amino Acridine solution,* sterile water, or saline, etc. The choice of solution is less critical than the physical act of flushing.

If antibiotic therapy is indicated, penicillin remains the preferred drug, pending results of culture and sensitivity studies in the nonallergic patient. During the acute and subacute stages, 500 mg every six hours postoperatively is the minimal acceptable dosage. On occasion, the author has empirically prescribed 750 mg early in the treatment. Because of resistant strain emergence, 250 mg doses of penicillin are therapeutically inadequate in most cases. For patients allergic to penicillin, a growing number of clinicians seem to favor cephalosporins because of the high resistant-strain emergence noted with erythromycin. It must be remembered, however, that a small percentage of penicillin-allergic patients will also be allergic to cephalosporins.

Oral hygiene levels are usually poor in these cases and remedial counseling is indicated. If the opposing maxillary third molar is traumatizing the area, removal of the tooth will hasten the resolution of the acute mandibular problem. If the maxillary tooth cannot be removed for some reason, the impinging cusps can be flattened with a stone to reduce the mandibular area trauma.

Frequent intraoral soaks with hot saline solutions are extremely beneficial, not only as an aid to localization, but to aid hygiene. This solution is made by mixing one-half teaspoon of table salt with six to eight oz. of coffee-temperature water. The solution should not be swallowed. Fluids should be encouraged to assure proper hydration.

If a purulent exudate is noted, a sample for culture and sensitivity-testing, and Gram staining, if acute, should be submitted. All military medical facilities have at least limited culturing services available. These tests are often not enlightening since any anaerobes will be destroyed in the course of sampling and transfer resulting in a normal oral flora report. Nevertheless, a C & S is good insurance in case the patient worsens. For aerobic cultures, Biological Culture Sampling Tubes (FSN 6640-00-518-5462) are used; for anaerobic culturing, syringe aspiration is essential, with immediate transfer to special Anaerobic Specimen Collectors in accordance with directions on the tubes.

The author has defined his treatment regimens in the form of a clinically usable table (Table 1).

*Aminacrine HCL powder in 1:1000 Benzalkonium Chloride. Powder obtained from Sterling Organics, New York, NY.

TABLE 1. Pericoronitis Treatment Regimens

Normal Temperature (98.6°F ± .4°) Tooth to be Retained

1. Irrigate involved area, with special effort to cleanse under the operculum.
2. *If* maxillary third molar contributing to problem and is expendable, remove it.
3. Oral hygiene counseling; Analgesics as needed.
4. Hot saline mouthsoaks, 5 minutes out of every 1-2 waking hours.
5. After symptoms subside, evaluate for possible operculectomy, if indicated and feasible.

Normal Temperature (98.6°F ± .4°) Tooth to be Extracted

1. Anesthetize the area, then irrigate surgery site(s) thoroughly, prior to extraction.
2. Extract the involved tooth (teeth).
3. Oral Hygiene counseling. Analgesics as needed. Postoperative antibiotics only *if* removal was traumatic, environment is dirty, or other indications present.
4. Hot saline mouthsoaks as outlined above, beginning the evening or morning following surgery.

Elevated Temperature Tooth to be Retained

1. Irrigate involved area, with special effort to cleanse under the operculum.
2. Evaluate patient's clinical profile (good vs. bad oral hygiene, healthy patient vs. systemic disease, better vs. worse clinical course, etc.)—if trends and factors are negatively-oriented (i.e., adverse), consider antibiotic therapy.
3. If fluctuance noted, consider I & D, following administration of antibiotic therapy.
4. If maxillary third molar is contributory and expendable (only mandibular third to be retained), remove at this time.
5. Oral hygiene counseling, and analgesics as needed. Hot saline mouthsoaks 5 minutes out of every 1-2 hours.
6. Evaluate later for possible operculectomy, if indicated and feasible.

Low-Grade Elevated Temperature (> 100°F) Tooth to be Extracted

1. Administer antibiotic of choice IM or P.O., 1-1½ hours before surgery (penicillin or alternative).
2. Anesthetize the area, then irrigate surgery site(s) thoroughly, prior to extraction.
3. Remove the tooth (teeth) as atraumatically as possible.
4. Irrigate well at termination of procedure. Oral hygiene counseling. Analgesics as needed. Continue antibiotic for minimum of 5 days (longer if clinical course dictates need).
5. Hot saline mouthsoaks as outlined above, beginning the evening or morning following surgery.

High-Grade Elevated Temperature (> 100°F) Tooth to be Extracted

1. Make judgment based on findings—can patient be safely treated on outpatient basis, or should patient be hospitalized/referred?
2. Attempt to obtain local culture sampling for C & S, Gram stain.
3. Institute antibiotic therapy, preferably with a parenteral loading dose (IM, IV).
4. Irrigate involved area liberally. After blood level of antibiotics attained, consider extraction of tooth (teeth), taking into consideration local and systemic factors, skill and experience level of the doctor, clinical and military situation, etc.
5. Postoperatively institute hot saline mouthsoaks. Analgesics as needed. (If delayed surgery is planned, saline mouthsoaks are employed preoperatively as well). Force fluids.
6. Continue antibiotics for minimum of 7-10 days, as dictated by clinical course. Followup visits daily until improvement noted—if not dramatically improved in 24-48 hours, consider hospitalization for more aggressive therapy by specialists. Any *dramatic* trend for the worse is grounds for immediate hospitalization.

Summary

Third molar teeth can become diagnostic scapegoats because of hasty history-taking and cursory clinical examinations. Conditions that can mimic pericoronitis symptoms include sinusitis, tonsillitis/pharyngitis, cervical lymphadenopathy, muscle spasms, TMJ problems, ulcerations, burns, etc. Pericoronitis is a very specific diagnosis, normally accompanied by signs of irritation and inflammation in the area, although the degree of severity can vary. The presence or absence of temperature elevation is felt to be an important indicator of host defense reaction. Treatment is predicated on the desirability to remove/retain the tooth/teeth involved, the patient's systemic resistance, local factors, cleanliness, etc. The author has summarized his treatment regimens in a clinically-usable outline format.

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New Operational Entomology Training Course

The Navy Disease Vector Ecology and Control Center, Jacksonville, FL, has quotas available for a new course in Operational Entomology Training to be given 11-22 Jan, 10-21 May, and 9-20 Aug 1982. Students in this course will receive advanced training in applied vector-borne disease control that may be required in operational entomological support of disaster relief, combat, or other contingency operations.

The course is primarily designed for active duty preventive medicine technicians, environmental health officers, epidemiologists, and entomologists. Quotas are also available for Medical Department personnel assigned to Naval Reserve preventive medicine units.

Topics to be covered during the course include:

- Vector-borne disease profiles on malaria, encephalitis, filariasis, leishmaniasis, onchocerciasis, trypanosomiasis, etc.
- Field epidemiology principles for vector-borne diseases
- Contingency vector control principles
- Ground vector control operations and equipment
- Aerial dispersal in vector control operations
- Field vector surveillance techniques
- Laboratory identification of principal vectors
- Emergency vector surveillance and control procedures
- Contingency planning and problem solving

Prospective students should request local funding. Limited funding from the Naval Health Services Education and Training Command (HSETC).

Approval for attendance and funding for Naval Reserve personnel are in accordance with current policies governing active duty for training for naval reservists. Requests for quotas should be made through the Chief of Naval Reserve.

Quarters may or may not be available at NAS Jacksonville. Reservations may be made by calling the U.O.P.H. at Autovon 942-3138/3427, Commercial (904) 772-3138, or the U.E.P.H. at Autovon 942-3537, Commercial (904) 772-3537. Messing is not available for officers, but is available to enlisted personnel in quarters.

For quotas, course outlines, and future course dates contact DVECC, Jacksonville, Autovon 942-2428, Commercial (904) 772-2428.

Possible Role of Anaerobic Bacteria in the Persistance of Streptococcal Tonsillar Infection

LCDR Itzhak Brook, MC, USNR
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Infections caused by Group A beta hemolytic streptococci (GABHS) continue to present a serious problem in military populations, particularly those living in close quarters on ships, in barracks, and in recruit camps. During World War II streptococcal infection in naval personnel was responsible for more lost time than any other disease. (*1*) That this problem is still important today is indicated by the high occurrence of this illness as reflected by the annual admission rate of Navy and Marine Personnel (Table 1). The incidence of streptococcal sore throat and scarlet fever has shown a slow decrease over the years. These infections, however, still present major medical problems in personnel below 20 years of age. In fact, naval recruits were afflicted with streptococcal infections in a ratio of 5.8 to 1 in 1976 or 6.2 to 1 in 1970.

The problem with GABHS which has perplexed physicians for years is that many individuals continue to harbor the organisms for weeks and even months after treatment that should have been adequate by conventional standards. These patients can become symptomatic again with acute pharyngeal or tonsillar infection, and, most importantly, can be a source of spread of the infection to others. Failure to eradicate the streptococci from patients with pharyngitis can lead to rheumatic fever and glomerulonephritis. (*2*) Unfortunately, penicillin therapy administered intramuscularly or orally (*3*) does not eradicate the organism in up to 40 percent of cases. As a last resort, many clinicians choose to have the tonsils removed from chronic carriers or patients with recurrent tonsillitis who do not respond to several courses of antimicrobial therapy.

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Failure of Penicillin Therapy

Penicillin has been the mainstay for treatment of tonsillar infections due to its effectiveness against GABHS. Recently, however, increasing numbers of patients with tonsillar infections have not shown clinical improvement after treatment with this drug. (*4,5*) Various theories have been offered to explain this failure. Some investigators suggest that penicillin-resistant α-hemolytic streptococci appear in patients receiving prophylactic penicillin therapy (*6,7*) or that a shift in the oral microflora occurs after repeated oral penicillin administration that selects for an increased incidence of beta lactamase-producing strains of *Haemophillus influenzae, Staphylococcus aureus,* and *Bacteroides* sp. (*6,8-10*) It is quite possible that these beta lactamase-producing organisms can protect the GABHS from penicillin by inactivating the antibiotic.

Anaerobes and Protection of GABHS

Bacteroides melaninogenicus and *Bacteroides oralis* are gram-negative anaerobic rods that are part of the normal flora of the human mouth. Strains of both species have also been isolated from a variety of human oral infections. (*11,12*) Until recently, *B. melaninogenicus* and *B. oralis* were considered to be susceptible to penicillin. However, penicillin-resistant strains have been reported with increasing frequency. (*13,14*)

The appearance of penicillin resistance among these two species has important implications for chemotherapy. Many penicillin-resistant bacteria can produce enzymes that degrade penicillins or cephalosporins. Such organisms, present in a localized soft tissue infection, could degrade penicillin in the area of the infection thereby protecting not only themselves but also penicillin-sensitive associated pathogens. Thus, penicillin therapy directed against a susceptible pathogen might be rendered ineffective by the presence of a penicillinase-producing organism.

The possibility that penicillin-resistant anaerobic bacteria may pro-

tect pathogenic organisms has been studied for several years by Dr. Brook. In this study, 74 percent of the tonsils obtained from patients with recurrent tonsillitis contained beta lactamase-producing aerobic and anaerobic bacteria. (*14*) The beta lactamase-producing anaerobes belonged to the genus *Bacteroides* and included strains of *B. fragilis, B. melaninogenicus* and *B. oralis.* Many beta lactamase-producing strains of *Bacteroides* were found to be associated with other infections in the upper respiratory tract. These include chronic otitis and mastoiditis, (*15*) periodontal and peritonsillar abscesses and cervical lymphadenitis. (*10,17*) These findings may be due to the selective pressure of repeated administration of penicillin to patients with upper respiratory tract infections including recurrent tonsillitis.

Beta lactamase-producing anaerobes may "shield" streptococci from the activity of penicillin, thereby contributing to their persistence. The ability of beta lactamase-producing organisms to protect penicillin sensitive microorganisms has been demonstrated in vitro. When mixed with cultures of *B. fragilis* the resistance of GABHS to penicillin increased at least 8,500 fold. Simon and Surai(*10*) have demonstrated the ability of *S. aureus* to protect GABHS from penicillin. This phenomena is demonstrated in Figure 1. *S. aureus* was quite resistant to penicillin (i.e., grew close to the penicillin disk) while GABHS were very susceptible to it (i.e., growth on the plate was inhibited to a large extent, as is evident by the zone of the beta hemolysis). However, when these two organisms were plated mixed together (middle plate), GABHS were able to grow in close proximity to the penicillin disk, thus showing resistance to the penicillin.

The importance of this phenomenon in living animals was first demonstrated by studies of mixed infections of penicillin-resistant and penicillin-susceptible bacteria in rabbits. (*19*) Subsequently, Hackman and Wilkins were able to show that penicillin-resistant strains of *B. fragilis, B. melaninogenicus* and *B. oralis* could protect *Fusobacterium necrophorum,* a penicillin-sensitive pathogen, from penicillin therapy in mice. (*20,21*)

In current studies in the Medical Microbiology Branch at the Naval Medical Research Institute, we are testing in mice the hypothesis that beta lactamase-producing strains of *B. fragilis* and *B. melaninogenicus* protect GABHS from penicillin. This system simulates a clinical mixed

TABLE 1. Summary of Naval Medical Statistics of Hospital Admissions for the Diagnosis of Streptococcal Sore Throat and Scarlet Fever*

Year	1970	1971	1972	1973	1974	1975	1976
Incidence per 100,000 active duty Navy and Marine Personnel							
All ages	64.5	57.1	41.2	39.7	40.9	27.2	33.1
< 20 years	148.1	141.7	93.3	86.8	78.7	53.3	73.2
Incidence per 1,000 Recruits							
Navy	1.8	1.7	0.8	2.0	1.6	0.7	1.2
Marines	6.8	4.9	3.7	0.7	1.4	1.4	2.9
Total	4.0	2.9	2.1	1.4	1.5	1.0	1.9

*Prepared from Medical Statistics, U.S. Navy: volumes 104-107 (1970-1976)

aerobic-anaerobic infection and, therefore, is suitable for testing our hypothesis. The usefulness of clindamycin, a drug that is effective against both GABHS and beta lactamase-producing organisms, will be compared to that of penicillin in our animal model.

Carriage Elimination of GABHS

Several studies have suggested the possible effectiveness of clindamycin and its parent compound, lincomycin, in the treatment of recurrent streptococcal illness or the streptococcal carrier state. (*22,27*) The superiority of these drugs may be due not only to their effectiveness against GABHS but also to the sensitivity of other aerobic and anaerobic organisms which may "protect" the pathogenic streptococci by producing beta lactamase (i.e., *S. aureus* and *Bacteroides* sp.).

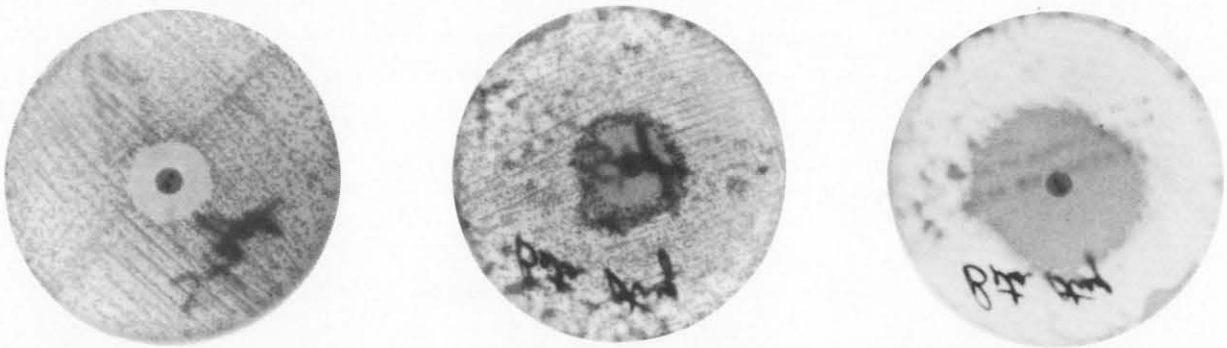
Breese et al. (*22*) showed that lincomycin was more effective than penicillin against streptococcal infections. No carriers of GABHS occurred among 100 children treated with lincomycin, whereas 12 carriers occurred among 102 children treated with penicillin. Randolph and DeHaan found a clinical and bacteriological recurrence rate of 13.9 percent after penicillin treatment as compared to 7.9 percent after treatment with lincomycin. (*23*) In a subsequent study Randolph et al. reported a 20.8 percent recurrence rate following penicillin therapy, as compared to 6.8 percent following clindamycin. (*24*) Levine and Beman compared clindamycin to erythromycin for treatment of streptococcal infection and found fewer bacteriologic recurrences in the clindamycin group than in the erythromycin group. (*25*) In another study Breese et al. compared lincomycin to penicillin for the eradication of GABHS and found only 16.1 percent failures in patients treated with lincomycin as compared to 41.4 percent failures in patients treated with penicillin. (*26*) Massell recently reported a comparative study using clindamycin and penicillin for the prophylaxis of streptococcal infections. Clindamycin was twice as effective as orally-administered penicillin for prophylaxis of streptococcal infection. (*27*)

Dr. Brook has treated 22 children who chronically carried GABHS and had recurrent tonsillitis with oral clindamycin for 7-10 days. All these patients responded to the therapy and a two-year followup showed the elimination of their carrier state for GABHS. Although there are many reports in the literature indicating the superiority of lincomycin and clindamycin to pencillin in eradicating the GABHS carrier state, almost all were done with young children and were completed 10-15 years ago. Furthermore, the investigators did not try to correlate the success rates with the presence of beta lactamase-producing organisms.

We are currently planning to perform a large clinical trial in Navy recruits, where the ability of penicillin and erythomycin to eradicate the carrier state for GABHS will be compared with that of clindamycin. This study should provide Navy physicians with an effective approach to control the GABHS carrier state and subsequently reduce streptococcal disease.

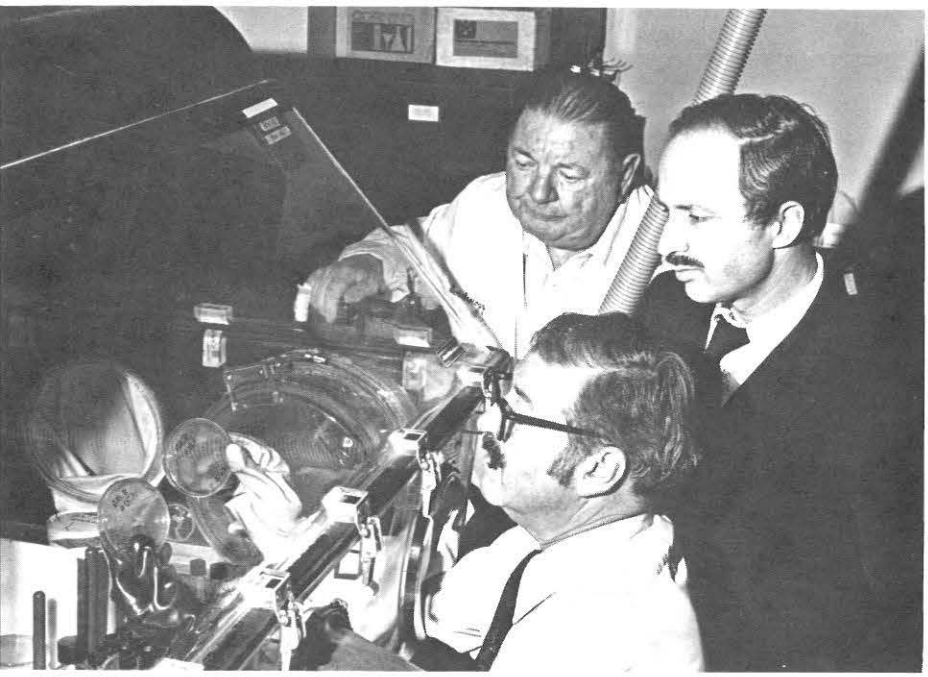
Conclusion

Tonsils can be colonized with various beta lactamase-producing aerobic and anaerobic organisms. The presence of these organisms in



Staph. aureus | **Staph. aureus + Beta Strep.** | **Beta Strep.**

FIGURE 1. Effect of S. aureus *on the susceptibility of GABHS to penicillin. A 10 unit (6 μg) penicillin G disk is placed in the center of each blood agar plate. Plate on the left:* S. aureus *is resistant to penicillin. Plate on the right: GABHS is susceptible to penicillin. Middle plate: Mixed with* S. aureus, *GABHS is resistant to penicillin.*



NMRI researchers examine plates incubated in an anaerobic (oxygen-free) chamber in order to determine effectiveness of antimicrobial therapy. Mr. James Perry (foreground). LCDR Brook and Mr. James Gillmore (background).

tonsillar tissue of carriers of GABHS may account for failure of treatment of the infection with penicillin. Data now available suggest that therapy should be directed toward the eradication of both the protective organisms and the pathogens.

As more data from in vitro, animal, and patient studies accumulate, a logical approach should be found for the eradication of tonsillar and other oral cavity-associated infections.

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